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JPRS L/8409

20 April 1979

TRANSLATIONS ON ENVIRONMENTAL QUALITY

(FOUO 4/79)

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JAPAN

NEW WATER POLLUTION CONTROL STEPS ADVISED

Tokyo THE JAPAN TIMES in English 30 Mar 79 p 2

[Text]

The Central Pollution Control Measures Council Thursday announced a recommendation on new water pollution control measures to be implemented for the Tokyo and Ise bays and the Inland Sea.

At present, only the concentration of pollutants in waste water is being restricted. Under this formula, pollution does not ease because polluters can discharge as much pollutants as they like if they discharge waste water after lowering the concentration of pollutants by diluting.

Under new water control measures, restrictions will be imposed on the volume of pollutants discharged by each industrial plant to seal this loophole.

The new measures are scheduled to become effective in June.

The Director General of the Environment Agency will allocate permissible levels of pollutant discharges to each prefecture to be covered under the new control measures.

Then prefectural governments will allocate permissible levels of pollutant discharges to individual industrial plants.

Thursday's recommendation outlines calculation formulas for such allocation and permissible COD (chemical oxygen demand) levels for various industrial plants.

COD levels have been set forth for 560 industrial plants in 207 categories to be covered by the new control measures.

Reduction goals to be attained by 1984 as well as interim goals to be achieved by 1981 have been set. In addition, separate goals have been set for plants to be built after June 1980.

For instance, the 1984 goal for bread and confectionery factories has been set at 80 ppm to 120 ppm, the interim goal at 120 ppm to 200 ppm and the goal for plants to be newly built at 80 to 100 ppm.

Prefectural governors concerned will allocate COD levels within these ranges in consideration of local conditions and waste water disposal technology levels.

Under the new pollution control measures, industrial plant operators are required to measure waste water discharge volumes and concentration levels of pollutants.

The recommendation called for the use of the same types of measuring instruments.

Pollutant discharge volumes will be computed by the same formula and records will be kept for a certain period.

CSO: 5000

JAPAN

FIRST CONVICTION UNDER 1971 POLLUTION CRIME LAW

Tokyo MAINICHI DAILY NEWS in English 8 Mar 79 p 1

[Text]

TSU, Mie—A local court, in a landmark decision Wednesday, found a chemical manufacturer and four of its employees guilty of violating the Pollution Crime Law.

These were the first convictions under the law, which took effect in 1971.

The Tsu District Court ruled that criminal negligence caused the leakage of chlorine gas from the local plant of Nippon Aerosil Co.

It fined Nippon Aerosil, headquartered in Tokyo, 2 million yen and gave suspended prison sentences to the employees.

The four employees are Norio Sugama, 41, chief of the manufacturing section of Nippon Aerosil's Yokkaichi factory; Mitsuo Funasaka, an employee of the section; Hiroyuki Tanaka, 27, a technician, and a 24-year-old technician who was not identified because he was, at that time a minor.

President judge Saburo Sakurabayashi ruled that the law is applicable to accidents as well as continuous pollution.

Gas leaked from a storage tank of the hydrochloric acid manufacturing plant in Yokkaichi, Mie Prefecture, on April 30, 1974.

The accident was caused by the unidentified technician who mistakingly pumped liquefied chlorine from a tank truck into a storage tank.

About 460 kilograms of liquefied chlorine vaporized into chlorine gas and spread over the area for about three hours, causing more than 10,000 residents to complain of sore throats and eyes and damage to crops.

The three other employees were found guilty of failing to properly supervise the unidentified man who was at that time a probationary employee.

The Pollution Crime Law is intended to punish both employers and employees who cause physical damage to the public by discharging pollutants through business operations.

A top official of the Ministry of International Trade and Industry said Wednesday that possibilities are now very slim of a similar accident occurring again.

He said since 1975 safety regulations on operations using poisonous gas have been substantially tightened.

New regulations, he said, require installation of leakage warning and cutoff devices at plants handling such chemicals. The ministry will instruct the industry to take as many safety precautions as possible, he said.

Despite the light sentence given to the polluter and its employees, the fact that the law was applied for the first time is quite epoch-making, observers said Wednesday.

Holding a polluter criminally responsible should constitute a serious warning to the nation's industrial circles which had tried their best to make the law as ineffective as possible when the law was being formulated, the observers said, adding that industry should be made more aware of their social responsibility.

CSO: 5000

JAPAN

OITA ECOLOGICAL SUIT DISMISSED BY COURT

Tokyo THE JAPAN TIMES in English 6 Mar 79 p 2

[Text]

OITA (Kyodo) — The Oita District Court Monday rejected a suit from local residents who had been seeking an injunction against an industrial development project under which about 430 hectares of coastal seas were to be reclaimed.

Judge Yutaka Tabata, who presided over the case, said the plaintiffs' action could not be considered a legal case because the project was still in blueprint and their rights had not been restricted in any way yet.

The suit was filed against Gov. Masaru Taki of Oita Prefecture in January 1977 by a group of 332 residents in Saganoseki.

It has been drawing wide public attention because it involves the problem of whether an industrial project can be blocked in the planning stages because of anticipated ecological damage.

However, in six past hearings on the case, arguments were focused on whether the suit should be taken up as a legal case or not.

On this score, Judge Tabata said the plan was still an administrative goal and it was not certain if the plan would be carried out.

The complainants have grounds on which to file suit when the project becomes a more definite reality, the judge replied.

A suit to stop the project in the planning stages may also be taken up for consideration.

However, Judge Tabata did not specify at what stage of planning, a suit can be filed to block an industrial development plan that has the potential to damage the surrounding environment.

The plaintiffs have been contending the hazards are great if the plan was implemented because a similar industrial complex has reportedly affected the health of residents.

Judge Tabata admitted there was a high incidence of bronchitis among people residing near that complex and noted the administrative authorities were neglecting efforts to improve the existing situation.

Monday's ruling is expected to influence similar suits in various parts of the country.

The project is part of a more comprehensive industrial development project under which a total of 2,000 hectares of ocean along a 20-km coastal line from Oita to Saganoseki will be reclaimed.

The first phase of the project has been completed and a petrochemical and steel mill complex is now in operation.

In 1970 the second phase of the plan was altered and the project was shifted from Kitsuki to Saganoseki.

CSO: 5000

JAPAN

SUIT AGAINST CRUDE OIL TRANSSHIPMENT STATION REJECTED

Tokyo THE JAPAN TIMES in English 30 Mar 79 p 2

[Text]

NAHA (Kyodo) — The Naha District Court Thursday turned down a suit from a group of local residents who are seeking to prevent the construction of a crude oil transshipment station (CTS) in the Kin Bay of Okinawa Island.

This is the first suit aimed at preventing the construction of a CTS in the country and has thus been drawing a wide public attention.

The suit was filed by a group of 1,250 residents near the planned CTS site against Okinawa Oil Base Co. and Okinawa Terminal Co.

Thursday's hearing opened at 2 p.m. but ajourned in about 10 minutes because the plaintiffs submitted new evidence on waste water disposal at a CTS and demanded that they be allowed to reopen their case.

Presiding judge Takao Inemori reopened the hearing at 2:23 p.m., handed down a ruling of rejection and closed the hearing at 2:28 p.m.

Because of this, the court room was thrown into confusion as spectators in the gallery shouted protests against the ruling.

The court called in policemen to control the protesters and more than a dozen of them were evicted from the court.

The plaintiffs and their attorneys also walked out of the court room in protest.

The presiding judge thus read his ruling in the presence of only the defendants and their attorneys, reporters and several neutral spectators.

Okinawa Oil Base Co. plans to build 21 crude storage tanks each with 100,000 kl by reclaiming 2 million square meters of water rescources between Henza and Miyagi Islands in the Kin Bay.

The construction work for the storage facility is now under way.

Further, Okinawa Terminal Co. is now building four oil storage tanks adjacent to the CTS.

Local residents opposed to the project formed an association and filed the suit to block it.

In past hearings, the plaintiffs argued that:

—The reclaimed land is sitting on fragile grounds and uneven ground subsidences are expected. (Uneven ground subsidence is a major reason for oil storage tank accidents.)

—Okinawa's climate is characterized by high humidity and temperature. Thus oil storage tanks rust faster than in other areas which could become a cause for an accident.

—Reclamation work will contaminate the sea as well the residents' living environment.

On the other hand, the defense counsel claimed that the ground in the area was sufficiently hard and that since the specifications of tanks met requirements of the Fire Prevention Law and Japan Industrial Standards, there is little danger of tankers to break.

The court announced the ruling after holding only seven hearings since July 1977. The plaintiffs asked the court to call 11 witnesses but the court allowed only two witnesses to testify for the plaintiffs.

Upholding the defense counsel's arguments, the ruling said the reclaimed land is standing on sufficiently hard ground and there is no structural problems involved in the storage tanks.

Since the Kin Bay is sufficiently deep for a large tanker to sail safely and its current is gentle, there is little possibility for a large scale oil leak accident to occur in the area, the ruling said.

The ruling further stated that even if a large scale fire should break out inside an oil fence, there is no possibility that the plaintiffs' life and health would be damaged.

After the hearing, an attorney for the plaintiffs told reporters that they felt as if the court denied the people's rights to be tried.

He said the court denied itself by refusing to try their case.

He added that the plaintiffs would decide whether to appeal or not within two weeks.

CSO: 5000

USSR

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INTERNATIONAL CONFERENCE ON ENVIRONMENTAL EDUCATION

Moscow VESTNIK AKADEMII NAUK SSSR in Russian No 2, 1979 pp 99-104

/Article by Candidate of Agricultural Sciences K. P. Mitryushkin and Candidate of Biological Sciences L. K. Shaposhnikov: "Education in the Field of Nature Conservation"/

/Text/ Nature conservation in our country is one of the most important state and national tasks. The measures on nature conservation, which are proclaimed by the USSR Constitution, and the decrees of the party and government on the implementation of measures to protect the environment and natural resources are being actively implemented. Now it can be stated with satisfaction that realistic results have already been achieved: erosion processes have practically been halted, the pollution of watercourses and the air has been reduced, the number of many valuable wild animals is increasing.

Nature conservation on our planet requires close international cooperation, for in nature everything is interconnected and many of its components, resources and factors which determine the vital habitat (the climate, the circulation of substances and so on) are common to all continents and countries of the world.

In the interests of environmental protection the Soviet Union and other socialist countries, since 1971, have been conducting joint scientific research, which is included in the General Comprehensive Program of Cooperation of the CEMA Member Countries and Yugoslavia for the Period up to 1980 in the Field of the Protection and Improvement of the Environment and the Rational Use of Natural Resources, Which Is Connected With This. The Council on Questions of the Protection and Improvement of the Environment, which determines the main directions of research in the field of ecology, coordinates its development and organizes the exchange of know-how, has been set up in the CEMA Commission for the Coordination of Scientific and Technical Research.

Within the framework of the UNESCO program "Man and the Biosphere" research has been conducted since 1969 at the institutes of the USSR Academy of Sciences and the institutions of various departments. The goal of this

program is to conduct in different regions of the world many years of comprehensive research on the influence of the activity of man on natural processes in the biosphere, as well as the reverse effect of the changes in these processes on man.

In recent years the Soviet Union has concluded bilateral agreements on cooperation in the field of nature conservation with the United States, Canada, France, Great Britain, the GDR, Italy, Sweden and other countries. Soviet specialists took an active part in drafting the section of the Final Accord of the Conference on Security and Cooperation in Europe, which is devoted to questions of environmental protection. In this section, in particular, it is noted that "the protection and improvement of the environment, as well as the conservation of nature and the rational use of its resources in the interests of the present and future generations are one of the problems which are of great importance for the well-being of peoples and the economic development of all countries...."[1] The need for a comprehensive scientific approach to environmental problems, the expansion of national and international measures on its protection, the exchange of information and the elaboration in the field of ecology of uniform scientific concepts and, as far as possible, a common terminology is stressed in the Final Accord.

The proposal to hold in our country an Intergovernmental Conference on Questions of Education in Nature Conservation became a new initiative of the Soviet Union. The expedience of convening this conference, the first of its kind, was recognized by many countries, and in 1976 the 19th Session of the UNESCO General Conference (Nairobi, Kenya) unanimously adopted the proposal.

The conference, which was entitled the Intergovernmental Conference on Environmental Education, was held by UNESCO in cooperation with the UN Environmental Program (UNEP) in 1977 in Tbilisi. Representatives of the governments of 66 UNESCO member states, observers from 2 states which are not members of this organization, as well as representatives from 8 organizations and programs of the UN system, 3 regional intergovernmental organizations and 20 international nongovernmental organizations--in all 330 delegate representatives, observers and experts--took part in the conference.

CC CPSU General Secretary and Chairman of the Presidium of the USSR Supreme Soviet L. I. Brezhnev sent to the conference participants a welcome message, in which he emphasized that the further development of economics, science and culture cannot be accomplished without taking into account the consequences of the influence of man on nature. In connection with this the inculcation of a cautious, attentive attitude toward the environment and the extension of the knowledge and skills, which are necessary for its

1. PRAVDA, 2 August 1975.

protection and improvement, should become an integral part of the overall system of the enlightment, education and training of personnel.

Chairman of the Georgian SSR Council of Ministers Z. A. Pataridze greeted the conference participants. He said that the understanding and solution of the problem of the interrelation between nature and man are urgent for all countries and therefore the recommendations, which the conference should draw up, would be of great importance for the entire world.

In a speech at the opening ceremony UNEP Executive Director Mostaf K. Tolba stressed the importance of nature conservation education as one of the means of attracting attention to pressing environmental problems. He emphasized that it is impossible to anticipate an improvement of the condition of the natural environment until broad groups of the population know about the important links between environmental quality and the economic activity of man.

In his welcoming speech UNESCO General Director Amadu-Mahtar M'Bou said that "both as a result of its activity on the protection and improvement of the natural environment and owing to its achievements in the field of education on this problem the Soviet Union has often played the role of a trailblazer."

Amadu-Mahtar M'Bou indicated that the UNESCO member states had already taken considerable efforts to include questions of ecology in syllabuses and to develop teaching manuals. The study of environmental problems should be a component of the overall process of education in all its forms and at all levels. The UNESCO general director declared that the development of education in the field of environmental protection is an exceptional field of activity for international and regional cooperation, since the solidarity of all peoples and all governments is a necessary condition for solving problems of environmental protection.

Corresponding Member of the USSR Academy of Sciences D. M. Gvishiani, deputy chairman of the USSR State Committee for Science and Technology, was elected conference chairman.

The conference discussed the main environmental problems in the modern world, the role of education in their solution and the ways of developing nature conservation enlightenment within the framework of regional and international cooperation.

In the lively discussion, as well as in the documents prepared for UNESCO and UNEP much attention was devoted both to national problems, forms and methods of their solution and to worldwide global problems of nature conservation and the dissemination of knowledge in this field. Many speakers noted that environmental problems should be a component of the general process of education in all its forms and at all levels of formal (at academic institutions of higher degrees) and informal (using mass means of information) instruction. The conference participants also indicated the need for

the coordinated development of educational measures, scientific research, development of educational materials, information of the public, the training and retraining of the personnel responsible for the work in this field and for the adoption of the appropriate legislative measures. The questions of disseminating knowledge on the protection of the natural environment and the rational use of natural resources at present attract much attention from specialists of various specialties in nearly all the countries of the world. To a certain extent the extensive use of new methods of research, particularly space technology, is promoting this.

Corresponding Member of the USSR Academy of Sciences D. M. Gvishiani, the head of the Soviet delegation, indicated in his speech that the goal of education in the field of environmental protection is to give man the necessary knowledge on how to use nature and its resources, how to control environmental quality. Today it is necessary to formulate the lofty goals of education in the field of environmental protection precisely in this way, since in a number of regions of the world the quality of the natural environment has achieved a condition which treatens the health of people.

USSR Deputy Minister of Higher and Secondary Specialized Education N. S. Yegorov told the conference participants about the principles and system of training of specialists on questions of environmental protection in the Soviet Union. He stressed that the higher and secondary specialized school of the USSR in the process of training skilled personnel is faced, on the one hand, with the problem of the nature conservation enlightenment and education of students in the spirit of a considerate attitude toward nature and the careful use of its resources and, on the other, by the problem of the vocational training of those who in the process of labor activity will be connected with a direct influence on the natural environment and with nature conservation. In recent years the organization of special nature conservation courses has been included in the practical work of training highly skilled specialists at the higher school. In these courses modern methods of mathematical modeling, the prediction of the economic consequences of production and so on are presented to the students.

I. P. Laptev devoted his speech to questions of the training of specialists of broad nature conservation specialization. He told about the activity of the nature conservation chair headed by him, which was created in 1974 in the geology and geopraphy department of Tomsk University. (The first such chair was organized in 1968 in the soil biology department of Kazan' University.) The training of environmental protection specialists is also being carried out at Tartu Iniversity, where the nature conservation study center was organized in 1966. In 1972 the chair of the use of nature was created at Rostov University.

Academician of the Georgian SSR Academy of Sciences V. Z. Gulisashvili told about the improvement of the skills of specialists of various specializations. He emphasized that when preparing syllabuses of education on questions of nature conservation it is necessary to take into account the nature of the production activity of the specialists.

While disclosing the strategy of nature conservation enlightenment in the Soviet general educational school, Member of the Academy of Pedagogical Sciences I. D. Zverev dwelt on the social class essence of the attitude toward nature as statewide wealth and public property. Under the conditions of a socialist society, where much is already being done to solve positively the problems of nature conservation, it is important not only to establish cases of emerging conflicts between nature and the activity of man, but also to analyze and explain to students from Marxist positions the causes of the emergence of such conflicts.

Soviet delegation member L. K. Shaposhnikov covered the activity of the Commission for Enlightenment of the International Union for the Protection of Nature and Natural Resources (IUPN) during the 27 years of its existence. The commission developed and disseminated in many countries of the world a general syllabus of the course "The Protection of Nature" for higher educational institutions, as well as manuals for the teaching of this subject in schools. The commission organized and held the first European Conference on Nature Protection Education (Switzerland, 1971), a number of seminars and working conferences on this problem in various regions of the world. An explanatory dictionary of terms on nature conservation in English, French, Spanish, German and Russian, which was prepared by the commission with the participation of specialists of the Central Laboratory of Nature Protection of the USSR Ministry of Agriculture and was published in Switzerland in 1977, was presented to the conference delegates.

The head of the Polish delegation W. Mihajlow told about experience of work and the outlined plans on education in the field of environmental protection in Poland. Representatives of other socialist and capitalist states devoted their speeches to these questions. The delegates of a number of developing countries spoke about the difficulties which they have come across in organizing nature conservation education (the shortage of specialists, the lack of textbooks compiled with allowance for local conditions), and noted the need to give them assistance in questions of nature conservation education on the part of international organizations.

The conference drew up basic recommendations on the development of nature conservation education, with which it turned to the states, as well as international organizations (above all UNESCO and UNEP).

In the conference recommendations a significant place is assigned to questions of the development of scientific research. Here it is noted that research should pursue the goals of improving the system, forms and methods of education in the field of environmental protection and should provide for the development of an interdisciplinary approach to the problem.

Taking into account that only comprehensive cooperation on the basis of specific plans is capable of yielding the necessary impact in the solution of global environmental problems, the conference recommended that all the states in conformity with their need outline plans of work on the

implementation of its recommendations and the dates of their fulfillment, and subsequently inform the other UNESCO member states and the UNESCO secretariat on the fulfillment of these plans.

Taking into account the importance of disseminating information for education in the field of environmental protection, it was recommended that the states single out from among the already existing organizations for nature conservation a national center for the sharing of know-how and information on a national and an international level.

The conference recommended that UNESCO jointly with other institutions of the UN system support in every possible way the activity of various national and regional organizations on the development of an educational network in the field of environmental protection, promote the development of syllabuses, projects and methods manuals, found an information bulletin, stimulate scientific research and develop a joint international program with UNESCO. In order to develop educational literature international contests should be held, UNESCO stipends should be established and prizes should be awarded.

The unanimity of the participants on the questions under discussion was reflected in the Declaration of the Tbilisi Intergovernmental Conference on Environmental Education. It is noted in it that nature conservation education and the dissemination of know-how should be aimed at all strata of society and should embrace people of all ages--administrators and specialists. The goal of the dissemination of knowledge in the field of environmental protection is "to encourage initiative, the sense of responsibility and the aspiration to build a better tomorrow."

In the declaration it is stated that the conference proposes that the states develop theory and scientific research in the field of education on environmental questions and calls upon them to cooperate in this field.

The implementation of the decisions and recommendations adopted by the conference will unquestionably serve the cause of peace and cooperation, the mutual understanding between states with different socio-economic systems.

After the intergovernmental conference in Tbilisi many USSR ministries and departments, as well as public organizations discussed the recommendations of the conference and outlined specific measures to develop nature conservation education.

The Section on Environmental Education, of which USSR Deputy Minister of Higher and Secondary Specialized Education N. S. Yegorov was approved as chairman, was set up within the Interdepartmental Scientific and Technical Council for Complex Problems of Environmental Protection and the Rational Use of Natural Resources attached to the USSR State Committee for Science and Technology. The section was instructed to coordinate the scientific and practical activity on nature conservation education in our country. The

coordination should provide for the mutual complementariness of different levels of education and the performance of ecological education among all age and social strata of the population, on the basis of an interdisciplinary approach to problems of environmental protection and the extensive use of the results of research in accordance with the UNESCO program "Man and the Biosphere."

The section has to analyze and evaluate the condition of education in the field of the environment in the USSR and abroad and develop with the participation of ministries and departments proposals on the improvement of the system of nature conservation education in the country. Here much attention will be devoted to questions of the training and improvement of the skills of specialists, to the promotion of the publication and the dissemination of the necessary scientific methods and informational materials. One of the immediate tasks of the section is the preparation for and holding of the first All-Union Conference on Environmental Education, which it is planned to convene in Minsk in 1979. The conference will tally the results of the activity on nature conservation education in the USSR and determine the ways of its development with allowance for the recommendations drawn up in Tbilisi. Representatives of various ministries and departments, as well as of public organizations, scientists and teachers will participate in the conference.

The section will perform its work in close contact with the subdivisions of ministries and departments, which are studying questions of the education and training and personnel, the All-Union Znaniye Society, the All-Union Council of Scientific and Technical Societies attached to the AUCCTU and the republic societies for the protection of nature. It should rest on the various scientific councils of the USSR Academy of Sciences and the USSR Academy of Pedagogical Sciences, universities and many VUZ's, as well as scientific research institutions.

In September 1978 the USSR and Georgian SSR ministries of higher and specialized secondary education held in Tbilisi the first All-Union Scientific Methods Conference on the Increase of the Level of Training of Specialists of Architectural and Construction Specializations in the Field of the Protection and Improvement of the Environment. The conference outlined specific measures of this training at higher architectural and construction academic institutions of the country.

Extensive work on nature conservation education has begun to be performed within the framework of the activity of UNESCO, UNEP, as well as various nongovernmental international organizations. The measures in this field have been included in the program and budget of UNESCO for 1979-1980. UNESCO and UNEP have begun the fulfillment of the operational plan of the International Program of Environmental Education, which is intended for up to 1983.

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CSO: 5000

FRANCE

DANGERS, EXTENT OF PETROLEUM POLLUTION DESCRIBED

Paris LA RECHERCHE in French Feb 79 pp 147-156

[Article by Pierre Nounou, chief, Environmental Protection Service, National Center for the Exploitation of the Ocean (CNEXO): "Petroleum Pollution of the Oceans"]

[Text] Almost one year ago the shipwreck of the Amoco Cadiz devastated 210 kilometers of Bretonese coast. Even though at the present time most of the sites seem to have resumed their normal appearance, we do not know as yet when the ecological balance will be re-established in the most profoundly affected areas. Better ship design and, above all, the strict regulation of ship traffic may, perhaps, avoid such tragedies in the future.

Unquestionably, more worrisome than the massive but accidental outpours of such black tides are the weak yet steady discharges in the oceans of hydrocarbons resulting from human activities, totaling millions of tons.

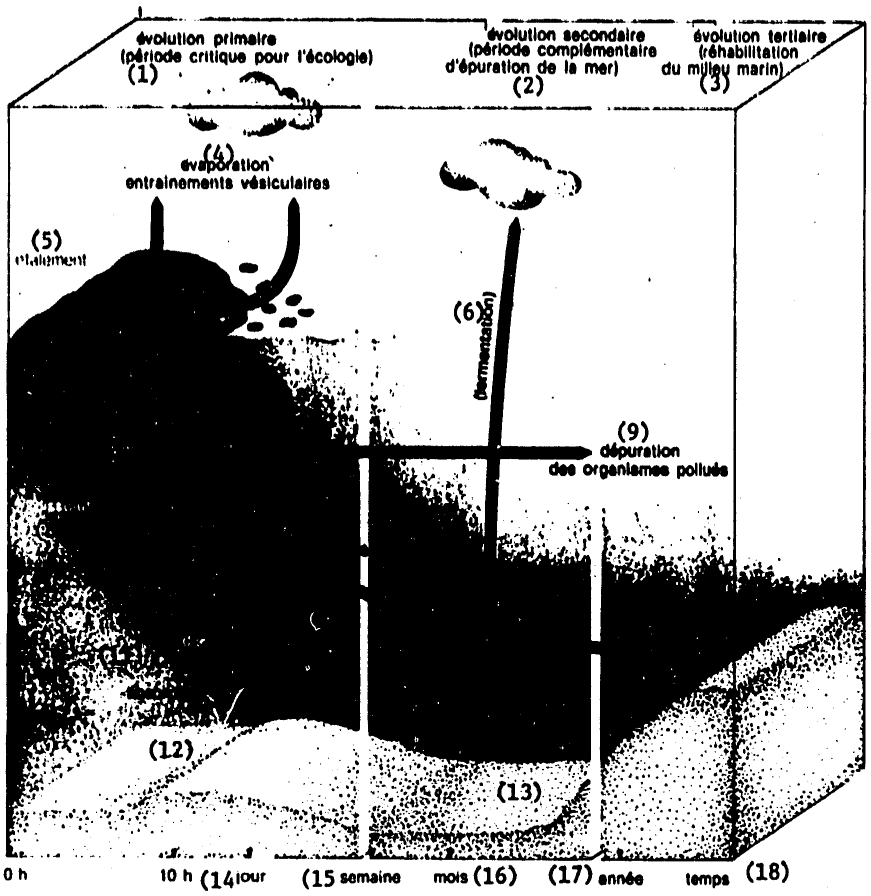

Figure 1. There are three stages in the evolution of petroleum at sea spreading over a period of several years. The first stage depends above all on physical processes (spreading, evaporation, dissolution, emulsion, and sedimentation; the second involves chemical and biological processes; the third corresponds to a period of resumption of the original balance of the marine environment. (Based on C. Bocard, G. Gatelier, and Ph. Renault, REVUE DE L'IFP, 33, 349, 1978.)

Key:

1. Primary evolution (critical period for the ecology)
2. Secondary evolution (additional period of purification of the sea)
3. Tertiary evolution (rehabilitation of marine environment)
4. Evaporation
   Vesicular drifts
5. Spreading
6. Fermentation
7. Emulsion (mousse)
8. Dissolution
9. Purification of polluted organisms
10. Oxidations
11. Dissolution
12. Absorption
13. Dissolution
    Sedimentation (microbial degradation)
14. Hour
15. Week
16. Month
17. Year
18. Time
19. Metabolism

Every year several million tons of hydrocarbons are released in the earth's oceans.[1] No more than a small share of about six percent is the result of accidental discharges due to shipwrecks or the use of hydrocarbons at sea or on land. Limited in terms of time and space, sudden and unpredictable, such accidents are spectacular and have a profound impact on public opinion. Yet, an experience based on several thousand accidents and the study of the most severe among them shows that, in the final account, the ecological damages they have caused have always been reparable or should be so under acceptable conditions. The deliberate discharges, slow, imperceptible, steady, caused by human activities are more worrisome. Their effects could even lead to genetic or cancerogenic disturbances affecting marine animals and even man. Such discharges account for over 90 percent of the annual tonnage discharged at sea.[1] They come from rivers, industrial or residential discharges, ballast discharges by coastal refineries, flushing of holds and tanks in marine transportation, the use of petroleum at sea, and atmospheric precipitation of discharges on dry land. The latter are estimated at 600,000 tons per year.[1] This source deserves particular attention since the hydrocarbons released in the atmosphere contain volatile aromatic compounds which are frequently cancerogenic. Benzopyrene alone accounts for 1,400 tons.[1]

Certain published statements notwithstanding, the natural release of hydrocarbons[2] might total 50,000 tons per year, a tonnage still considered substantial by geologists, bearing in mind proven reserves and drainage length.

What Happens to Hydrocarbons Following an Accident?

A considerable amount of data makes it possible to characterize the cycle of the hydrocarbons and the process of their shift to the various areas of the marine environment. Such data come both from studies following various accidents, observance within a national framework (Network of National Surveyance of the Quality of Marine Environment, for example), or on an international basis (Integrated World System of Oceanographic Stations, United Nations Environmental Program, etc), and research programs (International Oceanographic Decade Experiments, etc). Such studies enable us to distinguish among three stages in the evolution of hydrocarbons in a marine environment (Figure 1).

Initially (ranging from several hours to several days after a discharge), a very rapid surface spreading occurs (Figure 2), along with a spreading in the atmosphere (through evaporation following surface spreading), and dispersion in the marine environment (through dissolution or emulsification). After an accidental discharge the amount of evaporated petroleum ranges between 10 percent for petroleum or a heavy petroleum product (bunker C, for example) to 75 percent (in the case of light fuel). In the case of the petroleum discharged in the North Sea at the Bravo platform on the Ekofisk area exceeded 50 percent. Such processes depend on the physical properties

(density, viscosity, surface tension, vapor tension . . .) and chemical properties (composition, reactivity) of the various components (see Figure 1) as well as the amount of available energy in the medium, the type of environment, and the intensiveness of coastal processes. The source of this energy could be mechanical (winds, waves, coastal currents), thermal (air and water temperatures and temperature of the discharged petroleum), biological (microbial degradation) or chemical (photo-oxidation). The petroleum which washes off on the beaches could be cleaned through the same mechanisms, providing that the deposit does not spread in the shape of a cover on the surface of the sand.

This initial evolution of petroleum products separates the released products into two layers clearly distinct by their physical-chemical properties: the surface layers which combine the lightest products whose mechanical properties, in particular, are quite different from the mass dispersed in the water column. This stratification favors the establishment on the surface of the water of a film which presents two major inconveniences:

It slows down evaporation, and modifies the movement of the tides and the mechanical action of the waves;

It retains and concentrates through dissolution a certain number of chemical pollutants (organic chlorines, detergents, pesticides . . .); through polarized absorption it retains and concentrates other pollutants: chemical (heavy metals) or biological (bacteria, viruses); through solubilization, surfactant factors, whether natural (glycoproteins or polysaccharides) are added to the marine environment. According to J. D. Walker and R. R. Colwell, the mercury concentration in the samples taken from the water surface at Baltimore port would be 300,000 times higher than a concentration in sub-adjacent waters themselves quite strongly polluted.[3] The pollutants on the surface could be removed from the sea and carried at distances ranging from a few meters to several hundred kilometers through aerosols which develop on the water surface (see LA RECHERCHE, No 87, March 1978, p 209). In the course of this transfer, helped by the velocity of the wind and the agitation of the sea, the most volatile fractions could affect ecological systems far inside the land and become contagious to humans by depositing themselves on the crops (Figure 3).

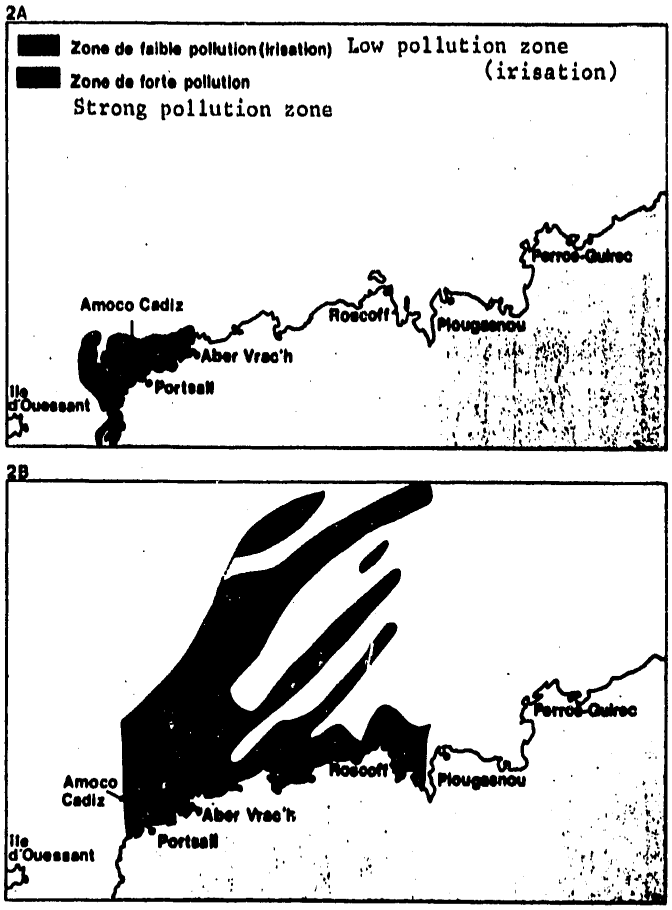

Figure 2. Aerial photographs in the clear in which infrared and thermal infrared have made it possible to draw maps of the spreading of the petroleum cover. These aspects which develop 2 (A) and 13 (B) days after the wreck of the Amoco Cadiz illustrate the primary spreading phenomenon caused by winds and currents. (Based on CNEXO, IFP, and IGN charts.)

In the water column emulsion remains the dominant dispersion process. It may assume one of the two main forms:

"Oil in water" (o/w) emulsion which forms on the surface and is subsequently dispersed by the currents and the turbulence of the waves, covering a distance of several hundred kilometers from the spill point;

"Water in oil" (w/o) emulsion, consisting of high molecular weight components, usually known, following the Torrey Canyon accident, as "chocolate mousse." It may contain as much as 80 percent water, depending on the nature of the oil. Natural or added surfactant agents may result, according to their nature, in one or another type of emulsion. Thus, a substantial crude oil fraction (containing hetero-atoms such as nitrogen, sulfur, oxygen, and phosphorus), with strong surfactant characteristics plays an important role in the dispersion of petroleum products. Should they be very fine, the suspended particles in the ocean (oxides, hydroxides, carbonates, and clays) play a role as well in this dispersion by stabilizing the emulsions.

Is Sedimentation Advantageous?

The progressive elimination of light hydrocarbons through evaporation, dissolution, or emulsification in water and the more or less intensive stirring of the emulsified components with the suspended matter inevitably drag the petroleum products to the sea bottom; this sedimentation is unquestionably the major process in their evolution. The duration and, consequently, the importance of the ecological impact of each such spill depend on it. The speed of the mechanism increases with the abundance of the sedimentation load (i.e., of the suspended organic and mineral particles in the medium) (in estuaries, fjords, and swamps . . .) and stirred up by the currents and waves (beaches, areas exposed with the low tide, or intercoastal areas). After the wreck of the Arrow tanker in February 1970, close to 300 kilometers of coastal area in Chedabucto Bay (New Scotland) were polluted by a Bunker C layer. The intercoastal sedimentation is still covered at some points by heavy polymerized residue resembling asphalt pavement which could be as much as 15 centimeters thick. Even though the crew headed by J. H. Vandermeulen and D. C. Gordon had predicted a contamination of the sediments covering several decades, the amount of hydrocarbons in the organisms living on such sedimentation was quite rapidly reduced to a level below the danger threshold. Actually, it is no longer possible to distinguish between the products spilled by the Arrow and other substances permanently present in Chedabucto Bay.

Depending on the speed of the phenomenon, the deposit of hydrocarbons on the bottom may be more or less nefarious to benthic life at the bottom of the ocean. Absorption by the sand or mud clears the marine environment from substantial quantities of the least soluble matter, i.e., of the heaviest and the least degradable; at the same time, this sinking slows down the biodegradation and, consequently, extends the eventual toxic action of such compounds.

Luckily Degradable Molecules

Most of the hydrocarbons kept in the water column and the sediments become degraded within a period ranging from a few weeks to several months through chemical or biological processes. Chemical degradation, photo-oxidation essentially, is initiated by a primary photolysis which gives birth to free strongly reacting radicals whose quick recombination results in a large number of chemical compounds such as polymers, oxidation products, and so on. These reactions are catalyzed by various agents such as heavy metals or by emulsification with the help of surfactant factors which favor the homogenizing of reagents within the same phase. The initial results of the American studies conducted following the Amoco Cadiz accident confirm the presence, in the areas surrounding the wreck, of a large number of heavy aromatic oxidation products with condensed nuclei (alcohols, aldehydes, and cetones), whose chemistry would enable us to predict their appearance.[4]

These results illustrate the importance of the degradation of hydrocarbons spilled in a marine environment through photo-oxidation. Frequently the resulting oxidized compounds are more soluble and, therefore, more accessible to the micro-organisms. Occasionally, they are also quite toxic. On the basis of theoretical considerations it has been calculated that a 2.5-kilometer-thick film, or 2,000 kilograms per square meter could, in principle, be eliminated in a few days of normal sunshine.

The presence of sulphureted hydrogen, among others, confirms the simultaneous role played by micro-organisms in the course of such oxidation. The bacterial degradation of hydrocarbons is, in fact, considered a predominant process in a marine environment. Laboratory studies conducted under conditions quite different from real life can provide no more than a very approximate idea of its importance in situ; according to American researchers who have minutiously followed the development of hydrocarbons following the Arrow and Metula accidents, it seems less effective than previously believed.[5] However, the process varies according to the microbial strata and it is possible that the micro-organisms may be less active in the cold areas of Canada and Patagonia where the accidents occurred than in a moderate or tropical zone. The nature of the products to be degraded is also influential: biodegradation is a specific feature of the molecular configuration of hydrocarbons; thus, linear chain alkanes (paraffinic hydrocarbons) appear to degrade best and the products of this transformation enable us to follow the cycle of the petroleum products flushed at sea.

Actually, studying the microbian flora of several zones of similar geomorphological configuration, such as Chesapeake Bay, on the eastern coast of the United States, the port of Baltimore, and Eastern Bay, proof was obtained that the microbian flora of the permanently polluted areas (such as the port of Baltimore) was different from that of the non-polluted areas and was better adapted to hydrocarbon degradation. Other factors as well influence biodegrading: temperature (Zobell has proved that some bacteria could degrade hydrocarbons at temperatures as low as two degrees

Centigrade), and pressure (recent experiments have proved that barophile bacteria present in deep sediment could degrade hydrocarbons in the absence of air as well).

These properties led to an attempt to seed hydrocarbon deposits with bacteria. However, this method is far from being an operational means for dealing with the problem considering the current state of our knowledge. Furthermore, some bacterial strata only store and subsequently reject the hydrocarbons without transforming them. This property is found all along the trophic chain. Thus, at the site of the accident involving the Arrow the plankton had absorbed substantial quantities of Bunker C in droplets, rejecting them 24 hours later with no transformation. The zooplankton, marine fowl, and most mollusks and crustaceans absorb hydrocarbons without degradation, rejecting them almost entirely after several days, retaining no more than 3 to 10 percent in their tissues. However, studies undertaken by Canadian researchers, following the shipwreck of the Amoco Cadiz, confirmed that some organisms (birds, fish, Annelida, and Polychaeta) were able to degrade some hydrocarbons absorbed through the activation of a detoxification enzyme, aryl hydrocarbon hydroxylase.[6]

Figure 3. Aerosols moved by the wind could carry the petroleum as far as cultivated land. In Brittany tempest winds during big spring tides have occasionally carried oil from the Amoco Cadiz as far as cabbage fields. (Illustration NOAA/EPA.)

Are Balls of Tar on the Beaches Inevitable?

In a third very long period of time hydrocarbons which have not been degraded in the course of the first two phases reach various compartments of the marine environment either as almost stable agglomerates (tar balls) or as accumulations, perhaps temporary, within certain living organisms, or else as infiltrations in most of the loose substrata. The tar balls are clearly visible in the high seas, along the major axles of maritime traffic and on the beaches. They consist of very heavy hydrocarbons (up to C40), oxidized, nitrogenized, or sulfurized, of mineral components (35 percent), ferrous oxides specifically.

The difficulty, not to say the impossibility, of eliminating from the marine environment massive spills of petroleum products has quite rapidly urged mankind to try to accelerate the natural processes of hydrocarbon dispersion at sea with the help of physical or chemical agents. Of all the methods, dispersion using surfactant agents and, to a lesser degree, leakage helped by precipitating agents, have been most frequently used and considered most controversial. Dispersion with the help of chemical surfactant agents aims at evading the formation on the surface of the water of a continuous film whose major inconveniences we have described. It energizes the breakdown of the hydrocarbon layers in accordance with meteorological-oceanographic factors, prevents the coating of marine, terrestrial, and air species, and, finally, benefits biodegrading. However, the factual effectiveness of the dispersing agents is currently quite controversial. Industrial detergents used to emulsify petroleum spilled by the Torrey Canyon, 10,000 tons for the treatment of 18,000 tons of petroleum, totally destroyed the flora and fauna of the tides balance zone spreading over 150 kilometers of Cornwall coast; today, however, 11 years later, the environment has been restored in its entirety. Furthermore, surfactant agents, increasing the probability that hydrocarbon droplets may come in touch with particles suspended in the water column, could encourage sedimentation on the bottom of quite light and volatile hydrocarbons which normally would have been eliminated from the marine environment through evaporation or dissolution. This is confirmed by the initial results of the follow-up conducted following the Amoco Cadiz accident. Furthermore, the dispersion agents used along the coast, particularly for cleaning the loose substrata could be used as vehicles favoring infiltration in depth of petroleum products which compromises biodegrading and contaminates burrowing species. Therefore, years later, old and totally inert hydrocarbons are deposited on the beaches, as in Tregastel, still from the petroleum spilled by the Torrey Canyon. Finally, after the surfactant has been diluted in the marine environment, the hydrocarbon molecules could be recombined through coalescence. The use of precipitants leads to the same dilemma: Do they eliminate the hydrocarbons from the water surface or increase the impact of pollution on benthic populations living on or in the sediments?

All Sites Are Not So Sensitive

The ecological follow-up of the sites carried out as a result of massive spill-outs in different parts of the ocean (wreckage of tankers, breaks of pipeline, or gushes in the course of operations at sea or along the coast) has allowed us to determine their consequences quite specifically. All studies agree on the following: Marine ecosystems destroyed by black tides have always regained their original balance except, perhaps, in some very adverse cases such as, for example, swamps whose loose soils are very vulnerable to hydrocarbons. A rough prediction of the overall impact of a massive spill-out and of the restoration capacity of the affected environment are possible on the basis of four series of basic data: the specific properties of the spilled components (quantity and chemical structure), the meteorological-oceanographic conditions of the spill-out which determine the energy displayed in the course of coastal processes, geomorphological characteristics and, finally, the biogeographic situation and ecological condition of the polluted site. The initial factors determine the physical limits of the spillage and, above all, its immediate toxic effects. The 9,000 tons of diesel oil (containing a high percentage of aromatics) spilled in March 1957 following the wreck of the Tampico Maru off the coast of Baja California (Mexico) killed instantly all forms of intercoastal and subtidal life over some 10 kilometers of coast, whereas the 10,000 tons of crude oil spilled out as a result of the accident of the Argea Prima tanker, in July 1962, in the Guayamilla port, in Puerto Rico, or the 5,000 tons of the same type of petroleum spilled at the Santa Barbara site, in January 1969, caused far less damage.

Studies of the geomorphological characteristics of the coast and its orientation in terms of the direction of hydrocarbon covers enabled M. O. Hayes and his fellow workers to formulate, following the shipwrecks of the Metula and Urquiola, a scale of sensitivity of sites to black tides.[7] The ecological follow-up of the Amoco Cadiz accident on the coast of Brittany made it possible to verify the validity of the scale.[8] Regional geomorphology determined the size of the pollution: the rocky promontories hit by the waves (vulnerability index: Vi=1) were barely affected, as the petroleum accumulated in the protected bays behind the islet (Vi=8) (Figure 4); the marshes of Grand Island (Vi=10) were the most strongly affected. Finally, the biogeographic and ecological characteristics determine the stability and resilience of the polluted system. Stability means the ability of a system to maintain its condition or to resume its initial state of equilibrium following a disturbance; it makes it possible to predict the long-term evolution following a disturbance as a function of the capacity of the environment to face a spillage of chemical products; resilience is the speed at which the system resumes it balanced state. As a function of the phases of the reproduction cycle of each species, the danger each one of them faces greatly varies in the course of the annual cycle. At the close of the winter season an inoffensive spill in terms of high seas species could cause great damage to nesting marine birds, to oysters, or to the larvae of crustaceans floating close to the water surface (see LA RECHERCHE, No 92, September 1978, p 751).

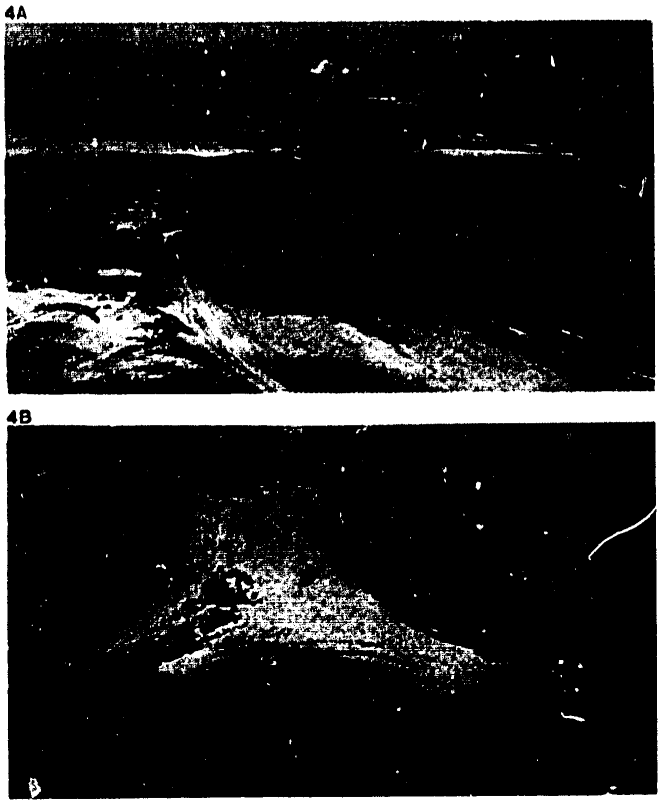

Figure 4. Crenelated bays (A) commonly found on the coast of Brittany and loops (B) are preferred areas for hydrocarbon deposits.
A. The part of the beach open to the wind is polluted.
B. Identical phenomena pile up sand behind an islet connecting it to the land and guiding the deposit of hydrocarbons. The photograph shows the accumulation of petroleum (dark grey) on both sides of the loop base where the beach (light grey) is less affected. (Plates by NOAA/EPA.)

Stability and resilience also vary according to the spill-out area. Thus, in a polar environment, where organisms have a long life and a reproduction period frequently spread over several months, a restoration of the initial balance of the environment, following pollution, would take a longer period of time. Furthermore, at such low temperatures the dispersion of the cover and chemical degradation are slowed down. Conversely, in a tropical environment, where biodegrading is faster, pollution has a less durable effect.

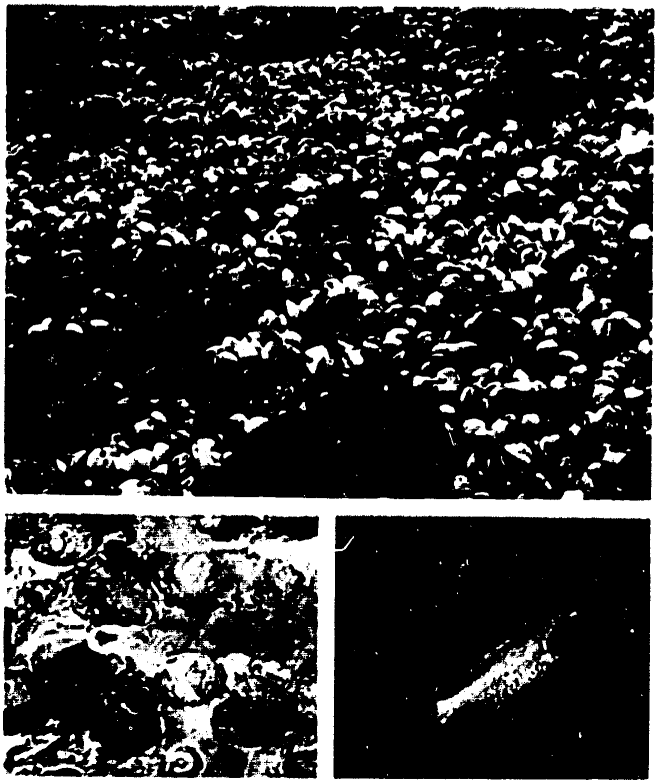

Figure 5. Looking at the hecatombs of shells, oysters, and fish following the Amoco Cadiz shipwreck in March, was it conceivable that many species would survive? The shells in the large photograph had been piled up on the beach by the waves and tides but had come from a far broader area. (Plates by CNEXO and Lovay-Atlas-Photo.)

The Immediate Impact Is Frequently Dramatic

Studies conducted as a result of the most spectacular accidents at various sites have dealt essentially with coastal areas. It is there that the impact of oil pollution is beginning to be best known. Generally speaking, the immediate effect following the brutal ingestion of toxic hydrocarbons by living organisms or their coating with the various spilled products results in the almost instantaneous and virtually total destruction of all life through poisoning, suffocation, or asphyxiation (Figure 5). Such mortality triggers ecological imbalances such as the increase of populations

of algae following the disappearance of the grazing species (gasteropoda). Subsequently, little by little, the balance is restored through a series of oscillations countering the density of the large trophic groups (vegetals, herbivorous animals, and carnivores). The spillage of fuel number 2 as a result of the wreck of a tanker barge in Buzzards Bay (Massachusetts) in 1969 caused the death of an enormous number of fish, mollusks, and other benthic invertebrates in the coastal areas of Wild Harbor, triggering the evolution of a great variety of benthic species in the direction of the only dominant species of the polychaeta worm (Capitella capitata) known for its resistance to pollution. The restoration of a proper environment, starting with 1970, has become total today, with the exception of a few very restricted areas in which some crab species remain affected. The 50,000 tons of Bunker C spilled in 1969 in Chedabucto Bay (New Scotland) polluted nearly 300 kilometers of coast and destroyed substantial quantities of shells, intercoastal crustaceans, and algae. Four years later the ecological regeneration of the zone was complete. Only a few species of bivalves (Mya arenaria) have failed to regain their former density. The wrecks of petroleum tankers which have affected the coast of Brittany have led to the same conclusions: following the Torrey Canyon accident in 1967 40,000 tons of old, heavy, and viscous petroleum reached the Cotes du Nord 45 days after the accident which, as was the case with the Amoco Cadiz, occurred in March. Studies made by the Roscoff biological station proved that the growth of large algae had not been slowed down by more than 10 percent the first year. Few living species were destroyed, with the exception of sea birds which suffered the highest casualties in the entire history of black tides (see frame 2). Other than such casualties today there is no ecological sequel to the accident. The wreck of the Olympic Bravery, in the course of which 1,500 tons of very heavy Bunker from the machine tanks were discharged on the rocks of the small Yusin Bay (Ouessant Island) had a limited ecological impact, and that of the Boehlen (about 4,000 tons of Boscan Venezuelan crude, containing practically no aromatics or light products) which caused minor damage to the mussels, reached by the petroleum several days after the accident. The studies launched by several agencies, following the wreck of the Amoco Cadiz, made it possible, three months after the accident, to confirm certain predictions formulated in the very first days of the accident, totally in accordance with the general trends of the reaction of the marine environment to the black tides (see frame 3).[6]

High Sea Accidents Are Less Tragic

Whereas accidental damages to the coastal waters and the coast are always quite substantial, accidents at high sea, far less frequent so far, have had quite negligible consequences. Their study faces a double difficulty. Seas in which no chronic pollution by hydrocarbons occurs are rare and the accuracy of reference points in high sea areas is not always adequate.

The spillage of 50,000 tons of hydrocarbons by the Argo Merchant, in December 1974, in the center of a fishing area, caused a substantial

mortality among codfish or codfish eggs and herrings in the vicinity of the wreck but with no repercussion on the overall affected populations. This can be easily explained by taking into consideration the overall population stock. The follow-up of the ecological results revealed that approximately one year later all the populations of contaminated species had been totally restored with the exception of some bird species whose mortality rate had been quite low. This example is a good illustration of the way an impact can be attenuated by natural factors such as the productivity of the environment which was at its lowest level at the time of the accident; western winds and very strong currents which blocked all intervention on the part of the American Coast Guard and which drove the hydrocarbons in an easterly direction. The surface dispersion and, consequently, evaporation were quite rapid. The vertical diffusion in the water column was quite limited and any accumulation toward the bottom was avoided. Natural conditions were even better at the time of the petroleum spill near Ekofisk, in the North Sea, at a time of very low primary production, very low water temperature, reduced spawning activities, and low biomass in the water and the bottom. The 12,000 tons of light petroleum spread over more than 4,000 square kilometers. The results of the work done by researchers from the Marine Research Institute in Bergen (Norway) together with Danish, German, and British researchers confirmed that the ecological damage was minor. At best a slight smell of petroleum could be detected in some fish caught during the eruption.[9]

The prospects of petroleum extraction in the high seas, nevertheless, has encouraged some governments to predict its impact on the marine environment.

Thus, the Council on Environmental Quality (CEQ) of the United States supports the hypothesis of a major impact caused by petroleum extraction in some high sea areas, off the Georgian and Alaskan coasts, and so on, particularly affecting certain high sea species which migrate toward coastal waters for spawning and reproduction purposes: their contamination at high sea could, by disturbing their migration and hindering their reproduction, lead to a dangerous diminution of the stock. According to the same study, flounder, smelt, sand eels, and gobys are fish species most vulnerable to hydrocarbons.

Those in charge of petroleum extraction in the North Sea have also tried to predict, on the basis of various models, the long-term consequences affecting fishing. One cannot entirely ignore the various effects of a chronic pollution which would dangerously affect the eggs of cod, haddock, flounder, whiting, and other gadoids, and sprats, luckily in small areas.

Prediction of Long-Term Effects

All these factors lead us to pursue the study of the long-term effects of a chronic pollution caused by hydrocarbons, particularly in some parts of the ocean, in the Gulf of Texas, where fishing has dropped, and in

Louisiana, where every year 100,000 tons of petroleum are spilled and where oil is frequently found on oysters.

Thus, for several decades marine pollution caused by hydrocarbons has triggered a considerable number of works and research projects. Unfortunately, laboratory experiments are hardly representative of natural ecosystems in which all sorts of interactions with the environment modify the effect of a substance, either because of the organism being able to escape or being unable to find food any longer. In order to compensate for such gaps a new approach was tried within the CEPEX (Controlled Ecosystems Polluted Experiments) international program. It consists of the controlled pollution of natural ecosystem fractions, limited through appropriate measures. This more global approach makes it possible to bring into play the sum total of ecological factors with a determining influence on long-term effects of accidental or chronic hydrocarbon pollution. Thus, investigations on the scale of hundreds of cubic meters of sea water, conducted by R. F. Lee, S. U. Takahaski, and J. T. Parson, in Sarnick Bay (British Columbia, Canada) made it possible to duplicate the profound changes in primary and secondary results observed as a result of certain accidents.[10] Such experiments, combined with in situ observations, enable us, today, to perceive better the eventual risks of a chronic hydrocarbon pollution. The areas most sensitive to this type of pollution are currently estuaries and ports. They were extensively studied by CIEM experts in Orielton in 1975. Well protected and characterized by specific dynamics, such areas are the privileged sites for a great variety of coastal studies. They are the spillways for substantial amounts of hydrocarbons from maritime traffic, refineries, etc, and are generally very polluted (from 800 to 3,500 ppm of hydrocarbons in terms of dry sediment weight, in Narragansett Bay, Rhode Island, for example).

Marine swamps are also quite sensitive to hydrocarbon pollution. Generally they are the centers of very intensive biological output, representing an important transitional area between marine and terrestrial ecosystems. Petroleum products discharged in such areas drop to bottoms consisting of substantial amounts of suspended matter. Over long periods of time they may be protected from the air and from all biodegrading. They contaminate species which feed on the waste which has absorbed them. Substantial damages of this type have been caused to the mangrove communities of Puerto Rico, following the Argea Prima accident, and in West Falmouth Bay after barges were run aground.

A Worrisome Phenomenon: Fish Necroses

Ingested hydrocarbons settle preferentially in the tissues containing substantial lipidic reserves, the liver, the hepatopancreas of invertebrates, the gall bladder, as well as the plasma lipoproteins, and all cutaneous and nerve tissues. These various hydrocarbon accumulation types provoke, depending on the organisms, following the disturbance of the cellular mechanisms, multiple disturbances in behavior, nutrition, reproduction, etc.

Frequently they result in cutaneous alterations such as necroses or tumors, following the destruction of mucous tissue.

According to the studies conducted by the Britons Halstead, Mearns, and Sherwood, 12 percent of a sampling of 16,000 soles taken in San Francisco Bay revealed an average of 33 tumors per individual fished in the vicinity of petrochemical industry spillways. Gardner, in 1973, followed by Barry and Yevich, in 1976, proved the frequent presence of neoplasma in shells (Menidia menidia and Mya arenaria) contaminated by soluble and insoluble Texas and Louisiana oil fractions, or of gonadal and hematopoietic neoplasma in 29 percent of animals caught along the Maine coast, permanently polluted by hydrocarbons.

Necroses could show up in the gonads, the central nervous system, the intestines, the liver, and the spleen of fish and sea mammals. They appear to be caused by the simultaneous effects of hydrocarbons and other pollutants such as cadmium and lead. We have no reason whatever today to claim that the ingestion of important amounts of hydrocarbons could, eventually, trigger cancerogenic effects in marine animals, not to speak of man. However, some types of petroleum contain rather substantial quantities of reputedly cancerogenic compounds (30 percent in the case of the Amoco Cadiz petroleum). Furthermore, the strongest concentration of benzopyrene detected in marine organisms (100 ppm in smoked fish, specifically), even though still below the hydrocarbon dose sufficient to alter the taste (200 to 300 ppm) could, nevertheless, reach 400 ppm in the vicinity of heavily industrialized coastal areas. The risk of increasing the contamination of man with hydrocarbons, based on sea products, is, therefore, real.

The current knowledge gained on the subject of hydrocarbons in the ocean and on their impact on the marine environment emphasizes a fundamental point: nature has one of the richest arsenals for defending itself against the black tides. It has surmounted and will continue to surmount massive spill-outs which, with the exception of accidental damages, frequently considerable, yet limited in terms of time and space, have never had irreversible ecological consequences. As in all the cases of previous accidents, and all cases of future accidents, the 220,000 tons of petroleum spilled out by the Amoco Cadiz were, successively and tirelessly, evaporated, spread over the sea surface, dispersed within the water column, and deposited on the sea bottom. This petroleum will stay there the longer the more the substrata it has infiltrated are loose and protected. It will be steadily biodegraded and destroyed chemically. In the course of this disappearance, all ecological balances will be progressively restored.

Conversely, the impact of chronic pollution of the marine environment remains largely underrated. What makes this threat even more worrisome is that nothing allows us today to predict its imminent disappearance. Supported by demographic expansion and economic growth, the growing size

of marine pollution by hydrocarbons, as much accidental as chronic, could bring about, regardless of current or future regulations, more severe long-term consequences than those of a massive spill-out. Acceleration makes this threat even more specific.

For Further Reading

On hydrocarbon pollution of the seas:

"Recovery Potential of Oiled Marine Northern Environment," JOURNAL OF THE FISHERIES RESEARCH BOARD OF CANADA, Special Issue No 35, May 1978.

"Fate and Effects of Petroleum Hydrocarbons in Marine Organisms and Ecosystems," edited by A. Wolfe, Pergamon Press, 1977.

"Effects of Petroleum in Arctic and Subarctic Marine Environments and Organisms," Vols 1, 2, and 3, edited by C. Malins, Academic Press, 1977.

"Petroleum Hydrocarbons in the Marine Environment," edited by A. D. McIntyre and K. J. Whittle, Vol 171, CIESM, August 1977.

"Pen Ar Bed, Sea and Coastal Pollution," Special Issue No 50, 1967.

J. L. Hyland and E. D. Schneider, "Petroleum Hydrocarbons and Their Effects on Marine Organisms, Populations, Communities and Ecosystems," "Proceedings of Symposium on Sources, Effects and Sinks of Hydrocarbons in the Aquatic Environment," Washington, D.C., 9 August 1976.

European Parliament Hearing, "The Pollution of Coastal Zones by Hydrocarbons," Council of Europe, Strasbourg, 1978.

Detailed bibliography of reports and publications on the Amoco Cadiz is steadily reprinted and could be requested from the documentation service of the Banque nationale de donnees oceanologiques, COB, Brest.

Particularly noted:

The NOAA/EPA preliminary report: The Amoco Cadiz Oil Spill, April 1978;

Proceedings of colloquium number six of the CNEXO, June 1978;

"Report by West Brittany University (IEM/UBO), 1978;

"Report by the Senate Investigation Committee," 27 June 1978.

FOOTNOTES

1. "Petroleum in the Marine Environment," National Academy of Sciences, Washington, 1975; "Impact of Oil in the Marine Environment," GESAMP, report number 6, 1977.

2. R. D. Wilson et al., "Ocean Affairs National Board," Academy of Science, 1973.

3. J. D. Walker and R. R. Colwell, "Impact of Oil in the Marine Environment," GESAMP, report number 6, p 51, 1977.

4. J. A. Calder et al., "The Amoco Cadiz Oil Spill," p 21, 1978.

5. R. R. Colwell et al., JOURNAL OF THE FISHERIES RESEARCH BOARD OF CANADA, No 35, 1978, p 573.

6. "Amoco Cadiz," Proceedings of Colloquium No 6, CNEXO, 7 June 1978.

7. M. O. Hayes and E. R. Gundlach, MARINE TECHNOLOGICAL SOCIETY JOURNAL, to be published.

8. L. d'Ozouville, E. R. Gundlach, and M. O. Hayes, op. cit., p 69.

9. JOURNAL OF THE FISHERIES RESEARCH BOARD OF CANADA, No 35, 1978, p 544.

10. R. F. Lee et al., BULLETIN OF MARINE SCIENCE, No 27, 1977, pp 119, 127; R. Parson, ibid., p 114.

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